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A COMPARISON OF SATELLITE-DERIVED LOW AND CIRRUS LEVEL WINDS WITH CONVENTIONAL WIND OBSERVATIONS

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A COMPARISON OF SATELLITE-DERIVED LOW AND CIRRUS LEVEL WINDS WITH CONVENTIONAL WIND OBSERVATIONS

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INTRODUCTION

The motions of low level and cirrus level clouds as observed in film loops constructed from photographs by the geostationary Applications Technology Satellite III (ATS-3) have been used to supplement conventionally observed winds in data-void tropical regions of the Atlantic and Eastern Pacific Oceans. One factor which contributes to errors in wind determinations made from ATS pictures is the uncertainty of target cloud height. The primary purpose of this study was to establish the suitability of (1) satellite-derived low level winds for use on the Analysis of the Tropical Oceanic Lower Layer (ATOLL) chart prepared by the Regional Center for Tropical Meteorology (RCTM) at the National Hurricane Center (NHC), and (2) satellite-derived cirrus level winds for use at the 200 mb level. Gaby and Poteat (1) have used these satellite-derived winds for climatological studies. Other studies -- Hubert and Whitney (2) and Serebreny, et al (3) -- have shown that low cloud motions correspond well with conventionally observed winds at about the 3,000 ft. level and cirrus cloud motions compare best with winds at the 30,000 ft. level. These studies at the cirrus levels, however, did not stratify the data by latitude, and our experience at Miami had led us to expect a better fit with the 200 mb winds for our area of responsibility.

PROCEDURE

An ellipse having a major axis of 4 degrees of latitude and a minor axis of 2 degrees was used to determine the eligibility of satellite-derived winds for comparison. A clear plastic tool bearing the ellipse was placed over a rawinsonde/pibal station with the major axis of the ellipse aligned parallel with the plotted wind. Whenever a cloud displacement vector (wind), low level or cirrus level, fell at least partly within the ellipse, comparison with the observed wind was made at 2,000 ft. and/or 850 mb or at 200 mbs.

The geographic regions and station numbers of the stations from which observations were taken for low level comparison were as follows:

Region	Stations	Region	Stations
Africa	415	Caribbean Islands	988,001,384,501
Atlantic Islands	016, 400	Panama	806
Brazil	899, 598, 288	Bahama Islands	118, 076, 063
Other South Amer.	405, 970, 413	United States	201
Lesser Antilles	954, 897, 861, 866	Mexico	644
Greater Antilles	526, 486, 367, 397		

The radiosonde stations that provided the basis for the 200 mb comparisons were:

Region	Stations
Africa	415, 641
Atlantic Islands	016, 020, 594, 902, 400
Brazil	899, 598, 229, 765, 193
Other South America	405, 970, 413, 222
Lesser Antilles	954, 897, 861, 866
Greater Antilles	526, 486, 367, 397
Caribbean Islands	988, 001, 384, 501
Panama	806
Bahama Islands	118, 076, 063
United States	201, 202, 211, 232, 250
Mexico	644

All comparisons were made using 1200 GMT charts and satellite winds derived from movie loops covering the period 1200 to 1600 GMT. The low cloud data sample consisted of 784 cases for the 2,000 ft. level and 778 cases for the 850 mb level. For cirrus level vs. 200 mb, the data sample consisted of 487 cases of which 211 were complete vectors (direction and speed).

RESULTS AND CONCLUSIONS FOR LOW LEVEL COMPARISONS
(Satellite-ATOLL [2,000 ft.] and Satellite-850 mb)

Figs. 1a and 1b represent graphs of direction *error* and speed *error* vs. percent frequency of occurrence. It is shown that a greater percentage of errors $\leq$ 10 degrees in direction and $\leq$ 5 knots in speed occurred at 2,000 ft.

Figs. 2a and 2b represent graphs of direction error and speed error vs. cumulative percent frequency. Significant points to be made are: (1) for direction, 61 percent of the cases were within 10 degrees of the 2,000 ft. winds compared with 53 percent at 850 mbs; and (2) for speed, 55 percent of the cases were within 5 knots of the 2,000 ft. winds compared with 49 percent at 850 mbs.

Satellite-derived low level winds compare somewhat more favorably with the 2,000 ft. level than with the 850 mb level, but the difference is small. These data appear well suited to use on the ATOLL charts. They probably are almost as suitable for use on the 1000 to 600 mb mean low level flow chart.

RESULTS AND CONCLUSIONS FOR CIRRUS LEVEL COMPARISONS (Cirrus vs 200 mbs)

Figs.3a and 3b show direction error and speed error vs. cumulative percent frequency. The most significant points to be noted are: (1) for direction, 73 percent of the cases were within 20 degrees of the 200 mb wind;and (2) for speed, 78 percent of the cases were within 15 knots of the 200 mb wind.

The methods employed for deriving cirrus level winds from ATS-3 movie loops provide a satisfactory data input at the 200 mb level for large areas where there are no other observations.

CAUTIONARY NOTE: The above comparisons were made for manually corrected ATS-3 derived winds (see Ref. 1) when the errors due to satellite diurnal motion were small. The diurnal satellite motion has become large and the suitability of the manually corrected wind is highly dependent upon registration of the pictures. At the NHC the corrections are now being made automatically using an electronic data grid digitizer coupled with the CDC 6600 computer at the National Meteorological Center, Suitland, Md.

ACKNOWLEDGEMENTS

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REFERENCES

1. Gaby, D.C. and K.O. Poteat, November 1971: A Provisional Climatology of Low Level Winds as Derived from ATS-3 Satellite Observations, NOAA Technical Memorandum NWS SR-61, U. S. Department of Commerce, 13 pp.

2. Hubert, L.F. and L.F. Whitney, Jr. 1971: Wind Estimation from Geostationary Satellite Pictures, Monthly Weather Review Vol. 99, 8 pp.

3. Serebreny, S.M., R.G. Hadfield, R.M. Trudeau, and E.J. Wiegman, 1969: Comparison of Cloud Motion Vectors and Rawinsonde Data, Stanford Research Institute, 20 pp.

NHC/SAS Wind Verification Statistics

Satellite-ATOLL (2000ft)--- VS. Satellite-850MB.——

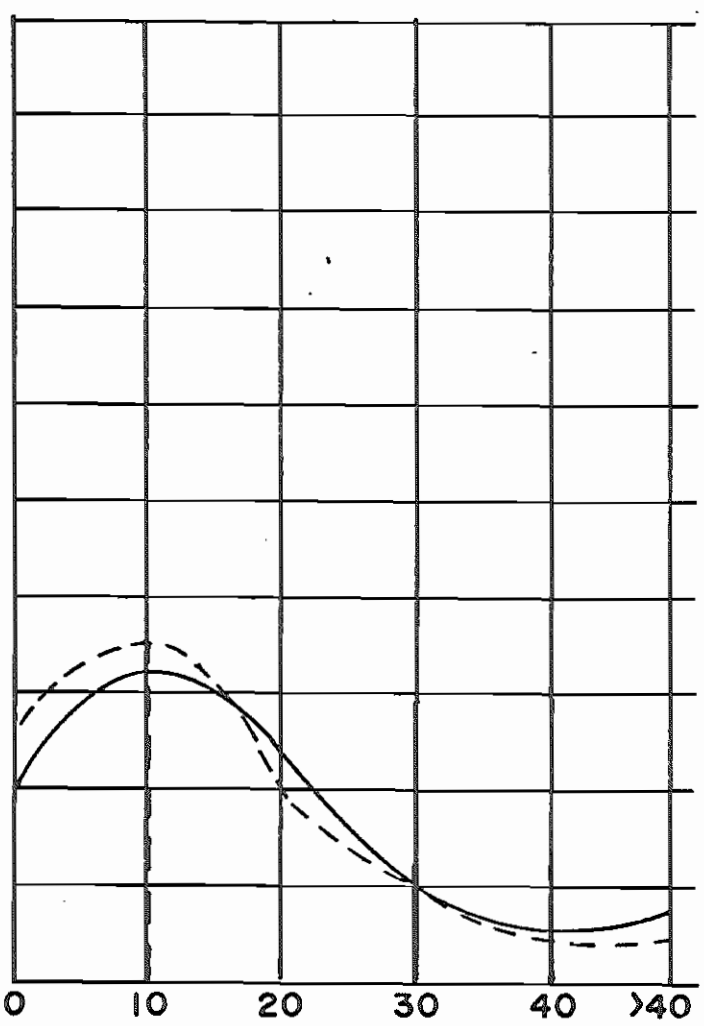


Fig. 1a

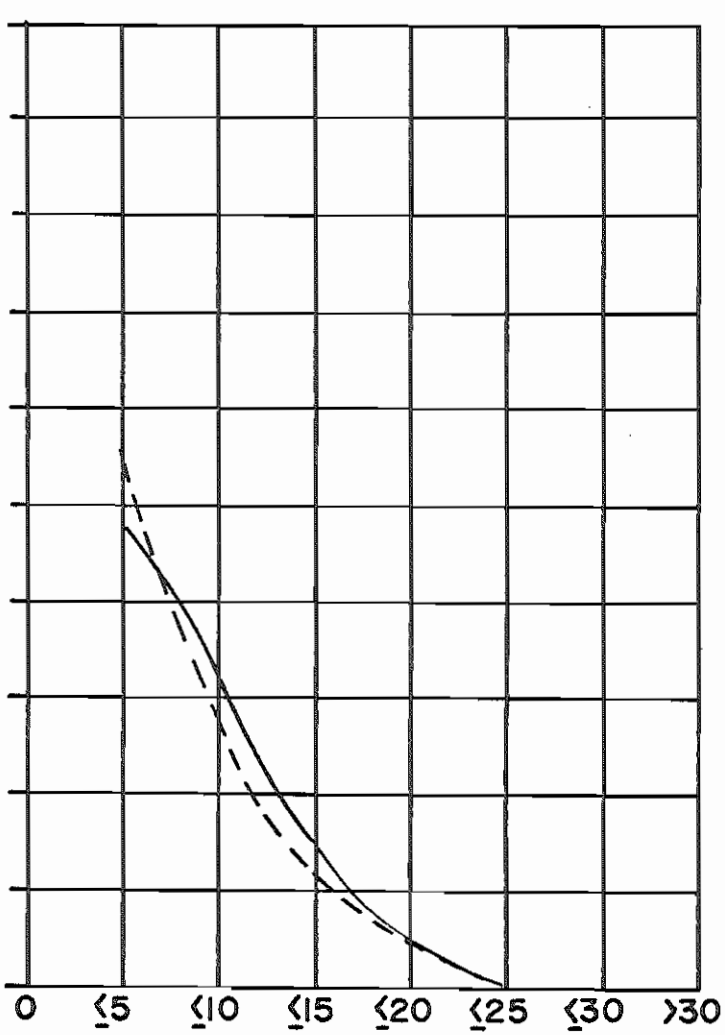
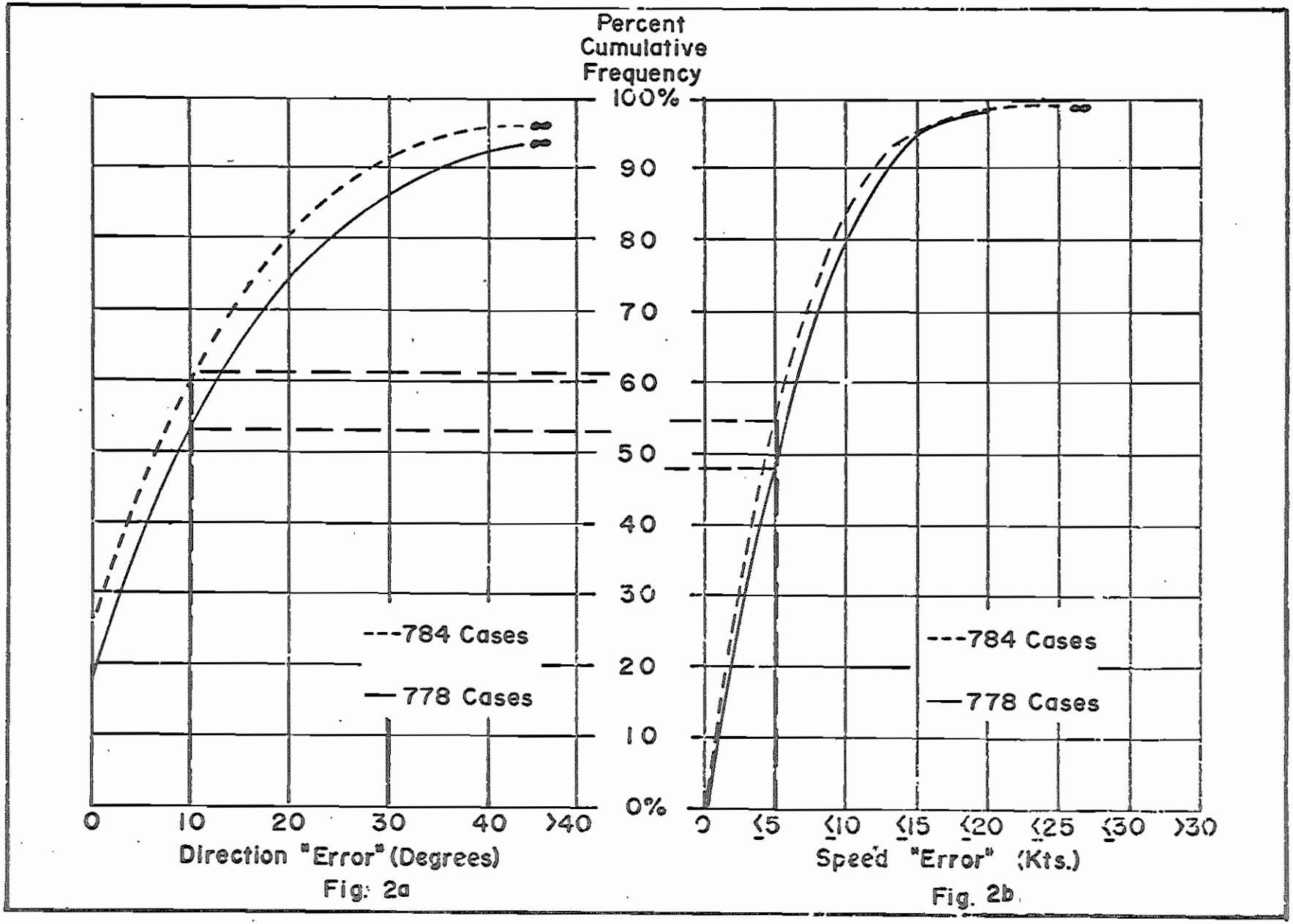


Fig. 1b

NHC/SAS Wind Verification Statistics

Satellite (Low Level) vs. ATOLL (2000ft lvl.) --- 850 MB. ———



NHC/SAS Wind Verification Statistics

(Cirrus level vs. 200MB.)

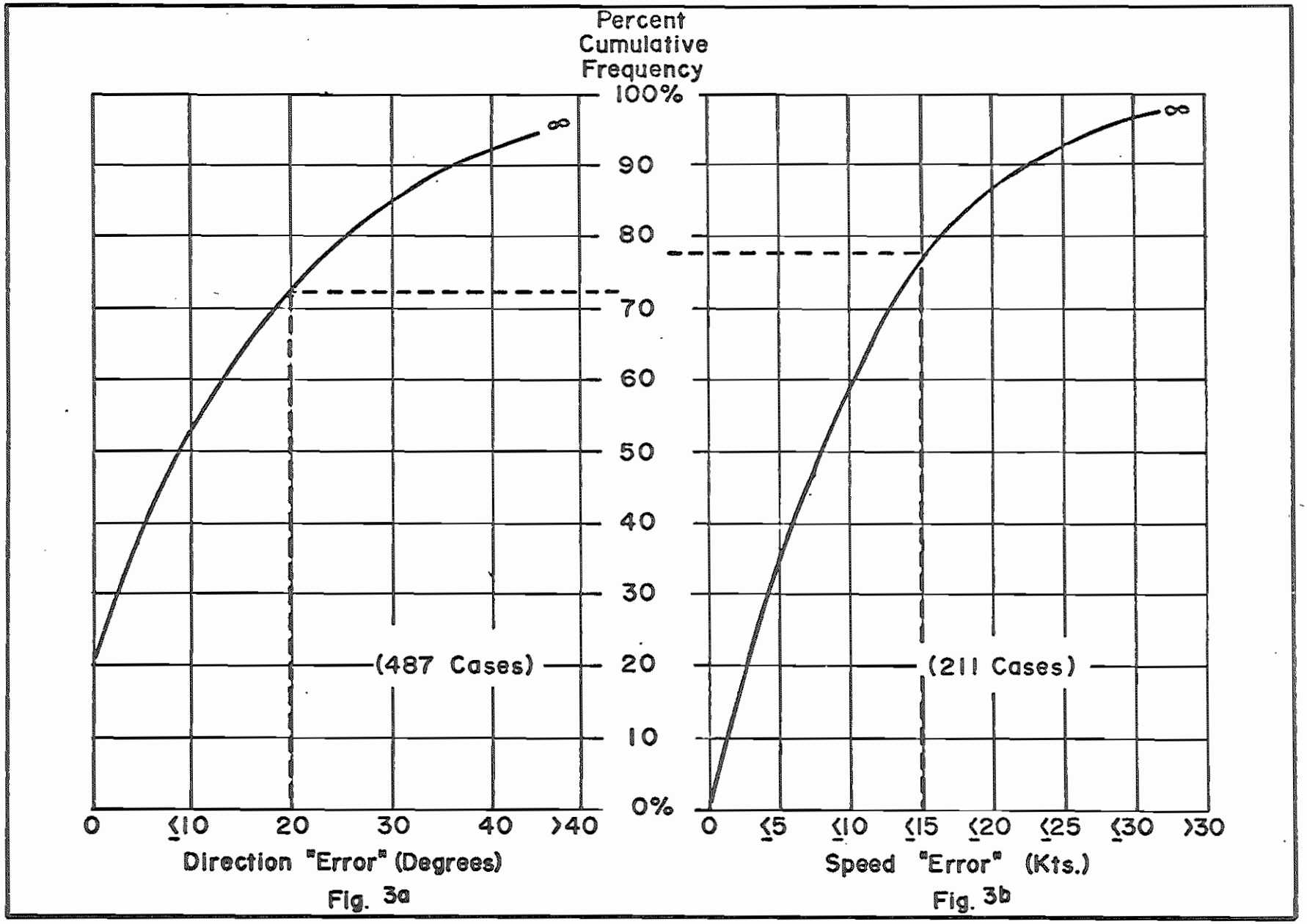


Fig. 3a

Fig. 3b